NEWFIELDS

§ 308 CWA INFORMATION REQUEST
TRADITION SOUTH DAIRY
Jo Daviess County, Illinois

Geophysical Investigation Results
Boring Recommendations for Packer Tests
September 29, 2011

This document includes the results of the Geophysical Investigation performed at the proposed Tradition South Dairy, and the recommendations for boring locations developed from the resultant data analysis. The geophysical survey was performed in accordance with Task 4.1 and contemporaneous with Task 4.2 (Background Stream Study) described in the *§ 308 CWA Request Work Plan* (NewFields, July 2011). The first round of background stream samples have been collected and are currently being analyzed. The second round of background samples will be collected coincident with but near the completion of the Man Made Voids Study/ Drilling and Packer Test program (Task 4.3). Dye Introduction for the Tracer Tests (Task 4.4) planned at each boring where packer tests warrant will be conducted before demobilizing the drilling equipment. As described in Task 4.3 of the work plan, this summary and the recommendations for boring locations are provided to USEPA for review and feedback prior to mobilization of the drilling equipment and will be discussed in a conference call set for 9 AM CDT on Friday, October 7, 2011 by dialing 1-888-546-0559 (6082832267#).

Geophysical Investigation

Fromm Applied Technology performed the geophysical survey at the site September 8 – 15, 2011. An electromagnetic conductivity survey (EM31) of the existing north basin, and capacitance coupled resistivity survey (CCR) of the existing west and proposed south basins were performed in accordance to the areas described in Figure 2 of the EPA approved work plan. Fromm's report of the survey is attached to this report.

Six survey control points were recorded to assist with documenting the site grid. These points were established with a portable GPS device. The grid was then used to perform the survey and collect more than 16,000 EM31 and CCR points at the site. Data from this survey was used at three selected cross-section traverses to develop geophysical pseudosections to aid with anomaly interpretation. Figure 1 shows the survey control points and site grid at which the data was collected. The three-cross sections superimposed on the proposed final basin design topography are also shown.[1]

The Fromm report describes in detail the results of the data evaluation. The results were closely evaluated for conductivity (EM31) signatures at the north basin and resistivity (CCR) signatures

[1] Previous discussions with USEPA identified physical restrictions at the site preventing complete geophysical traverses across the entire basins footprint. These included the steep embankment walls surrounding the north and west basin. The traverses shown on Figure 1 truncate at the north and west basins at each floor where the walls were encountered. Additionally, the blank area at the west central portion of the north basin is the location of a deep trench excavated to remove a field tile that was flooded at the time of the survey, prohibiting access.

at the west basin and the proposed south basin. The results are shown graphically on attached maps to the report that display an interpretation of the subsurface structure. The results of this analysis identified ten anomalies labeled A – J, shown on Figure 2 of this summary.

Boring Recommendations

The ten anomalies identified by the geophysics will each be investigated by installing a bedrock boring for further packer testing of the underlying bedrock, and an adjacent overburden monitoring well to monitor water levels in the overburden during the packer test. The location of each proposed drill site (T-1 through T-10) are shown on Figure 3 along with existing surface survey points as well as points where bedrock penetrations were historically advanced. Because of the data density of this information, supplementary Figures 4A – 4D show large scale views of the drill sites that include numerical labels for the nearby surface and bedrock elevations. These allow for an interpolation of the approximate thickness of overburden at each drill site. The table below describes each drill site along with the approximate surface and bedrock elevation and relevant information derived from the geophysical program.

Proposed Drilling Program[2]

Drill Site	Approximate ground surface elevation (msl)	Approximate bedrock surface elevation (msl)	Background
T-1	976	969	High conductivity values along linear feature at anomaly C
T-2	977	967	High conductivity values at anomaly A
T-3	977	963	High conductivity values at anomaly B
T-4	976	963	Low inverted resistivity values between high values at anomaly H (possible bedrock depression or fissure)
T-5	974	966	High inverted resistivity values between low values at anomaly J
T-6	979	966	Low resistivity at anomaly F resulting from data filtering
T-7	970	964	Low resistivity values between areas of high values along anomaly G
T-8	972	963	Low inverted resistivity values between areas of high values at anomaly I (possible bedrock depression)
T-9	966	962	Low resistivity values at anomaly D
T-10	968	960	Low resistivity values at anomaly E

[2] Elevations interpolated from data shown on Figures 4A – 4D; data were absent at mid center of proposed south basin; however, the area at boring T-7 is within a borrow area where approximately three feet of material has been removed below existing grade.

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As described in Task 4.3 of the work plan, the bedrock borings will be advanced to a sufficient depth below the bedrock surface to perform a packer test for potential future dye introduction. Task 4.3 of the work plan states that "*depth will be determined by the geophysics and drilling conditions encountered, but a nominal elevation of 935' msl is assumed.*" The 935-ft depth was selected because it was the lowest elevation previously investigated at the site, and represented a minimum bedrock penetration of 20 feet based on known bedrock depths. The actual depths that will be achieved will not be known until the bedrock is cored and conditions assessed at the time. A 20-ft minimum bedrock penetration will allow for an adequate thickness for the packer test to assess the hydraulic characteristics of the aquifer. However, the terminal depth at each site will be determined based on the rock conditions as well as the core recovery.

Further details regarding the packer test program and subsequent dye introduction (if warranted), are described in the work plan.

Future Activities

Based on the current work plan schedule, this document will be reviewed by USEPA and discussed in the conference call mentioned above. Following Agency approval of these recommendations, drilling will begin about one week following. Because four additional borings have been added to the original six described in the work plan, an additional seven days of field time for drilling and packer test activities are assumed to complete the packer test program. The timeline for the remaining activities remains unchanged.

Attachment Fromm Applied Technology – Tradition South Report, September 2011

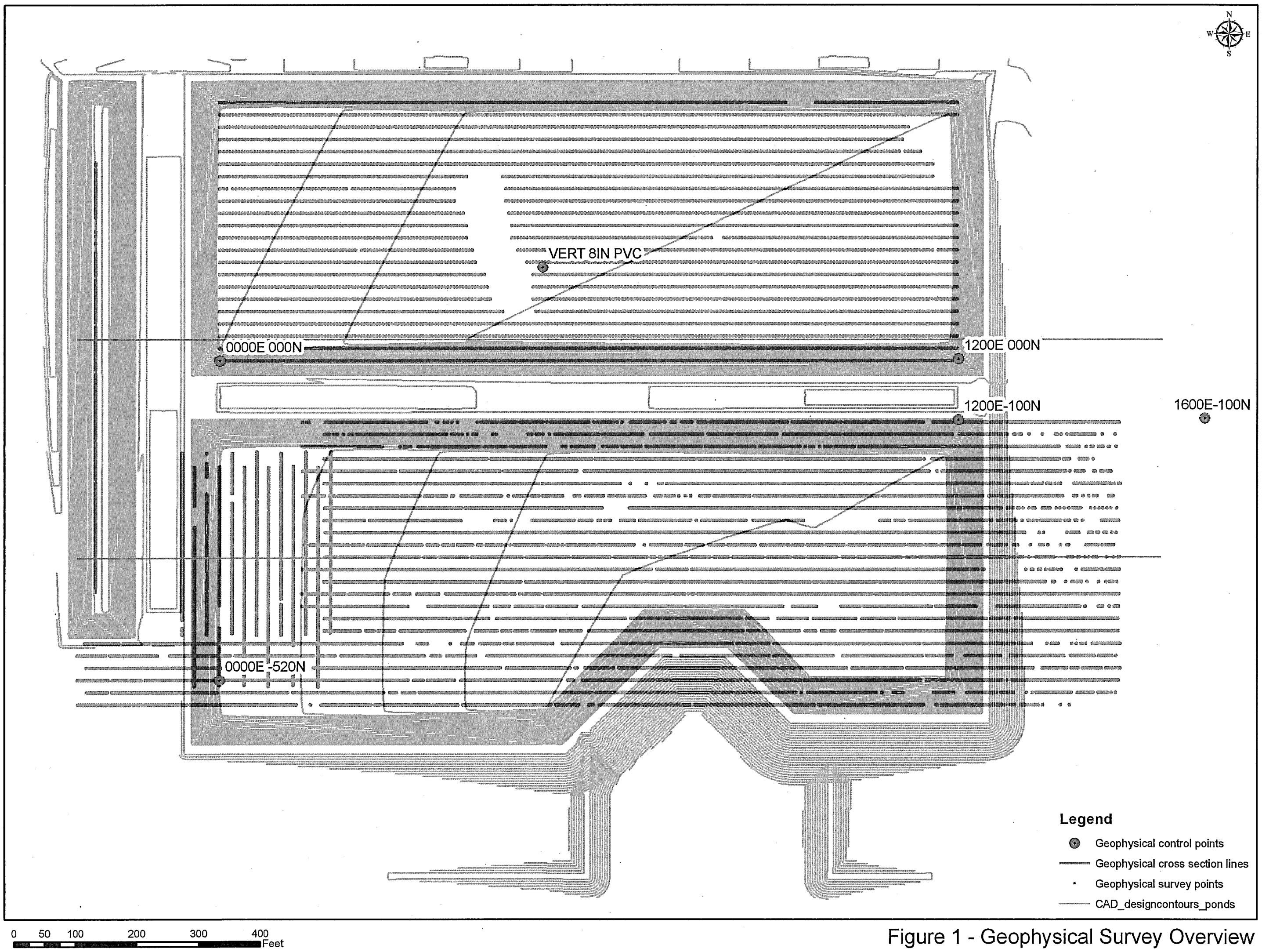


Figure 1 - Geophysical Survey Overview

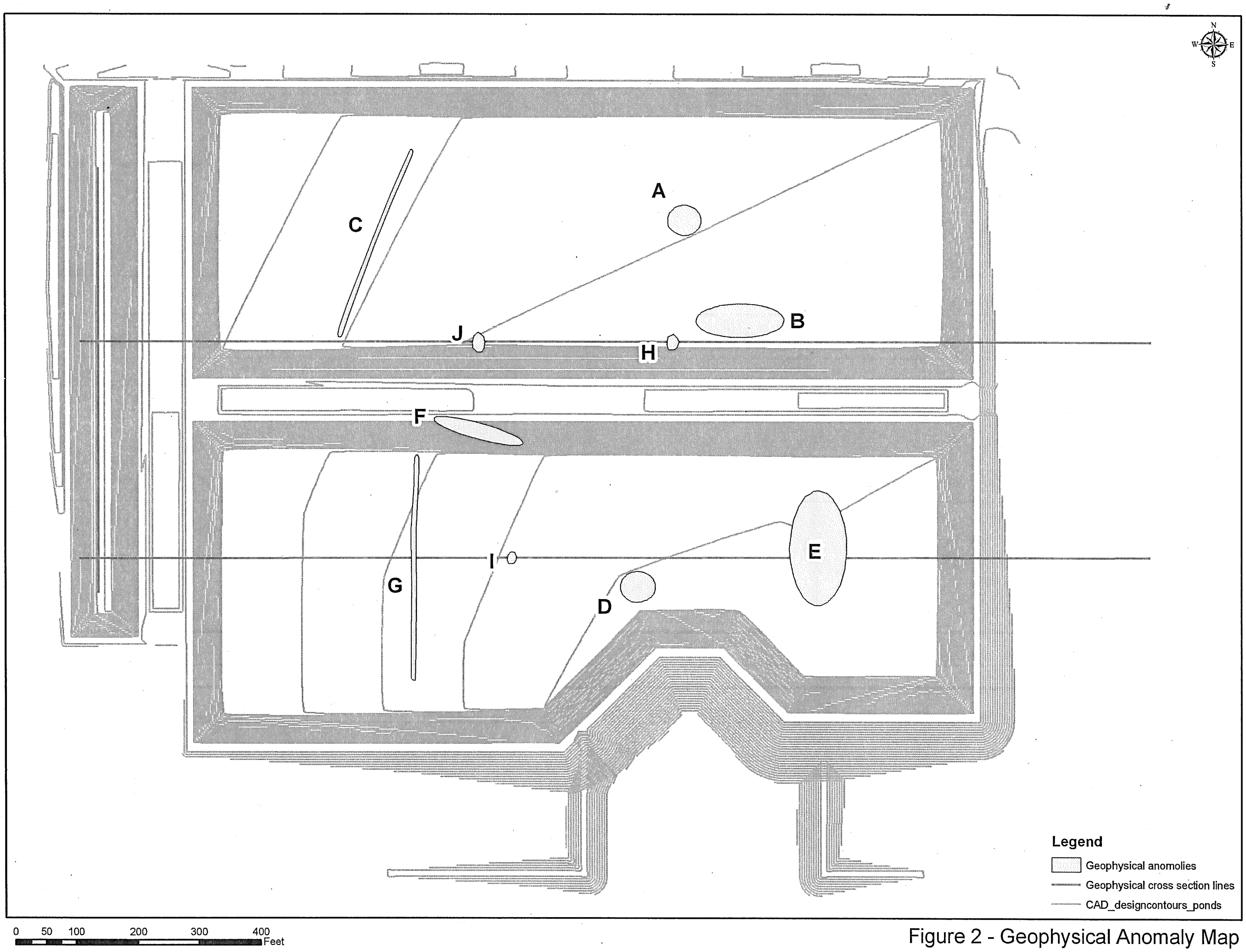


Figure 2 - Geophysical Anomaly Map

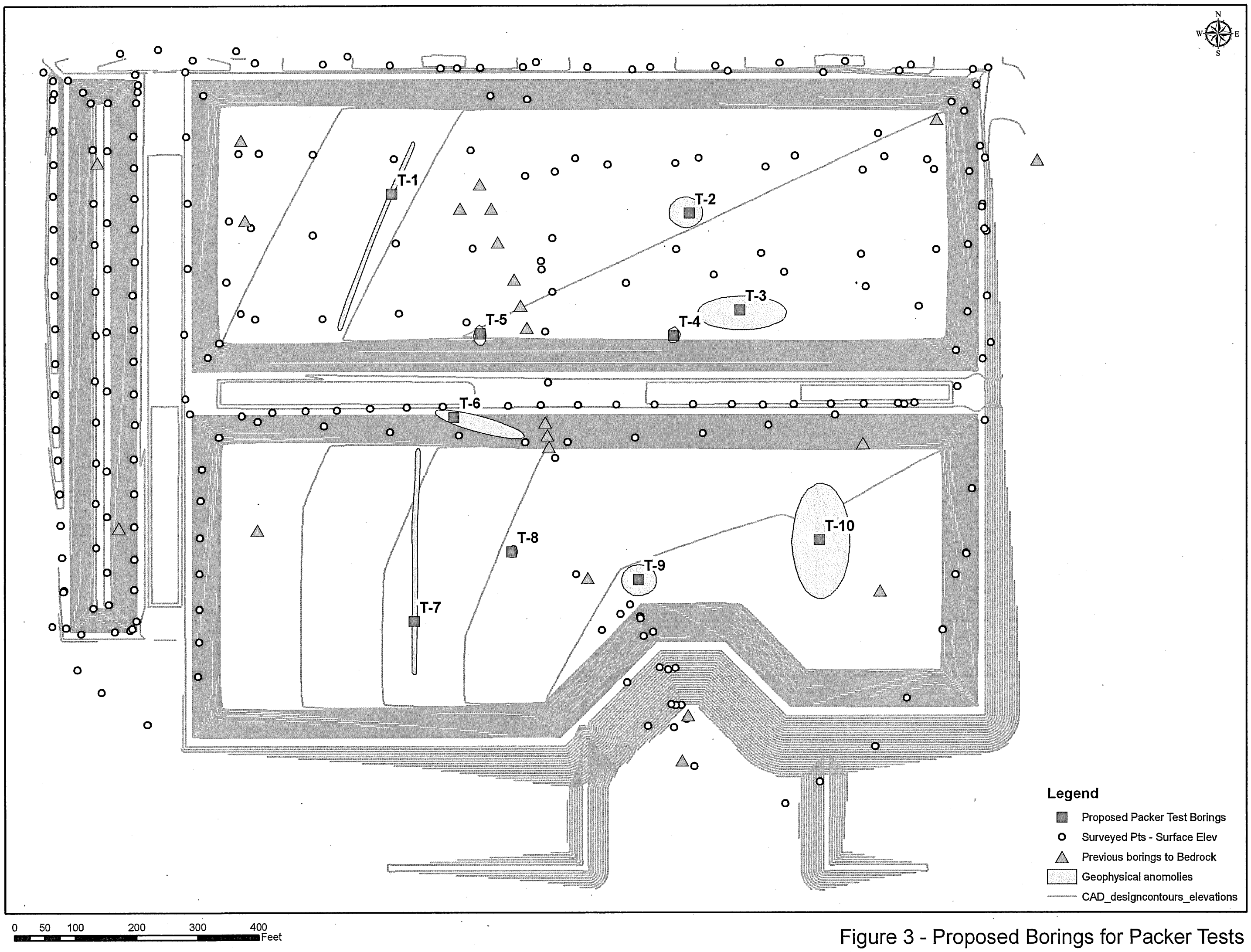
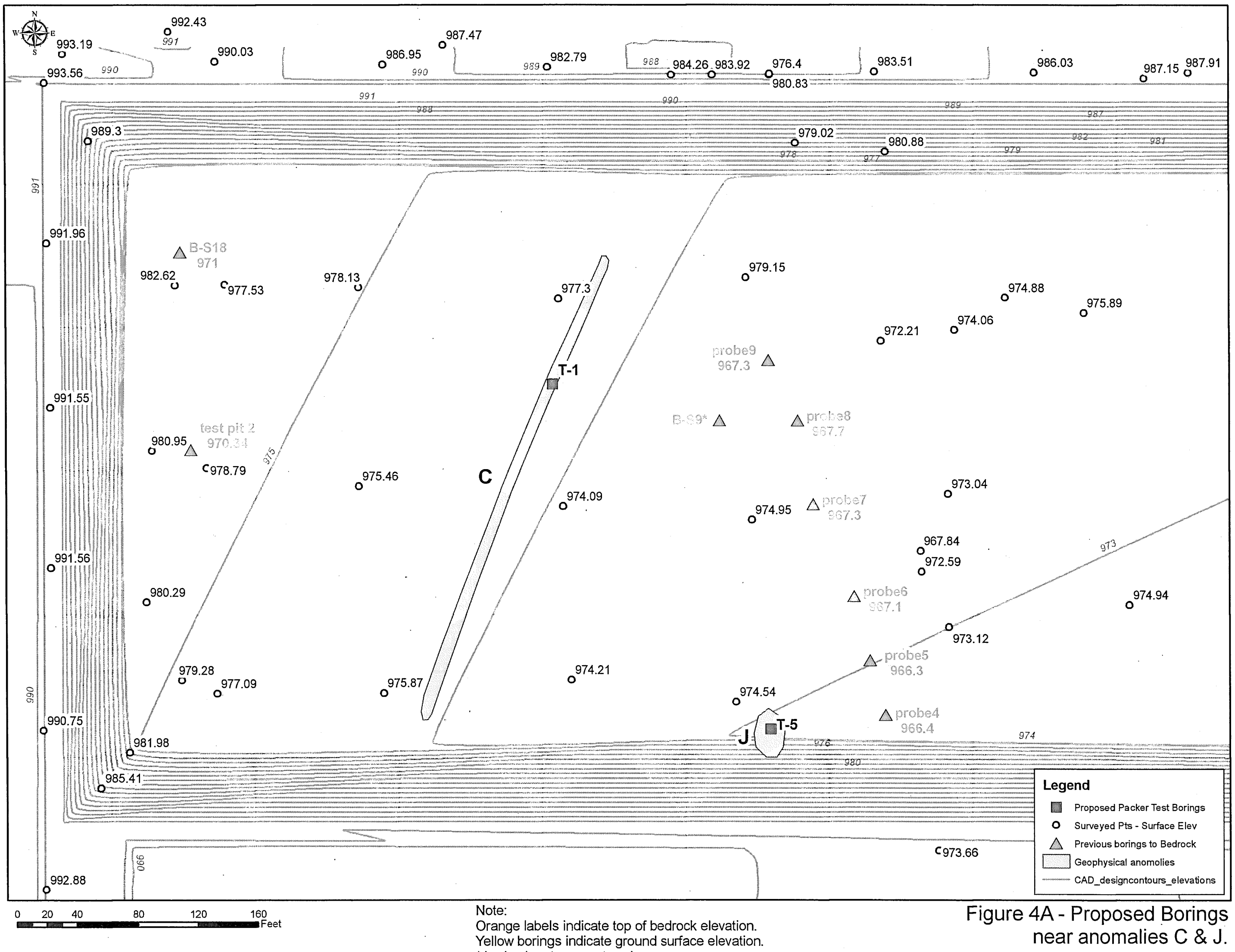
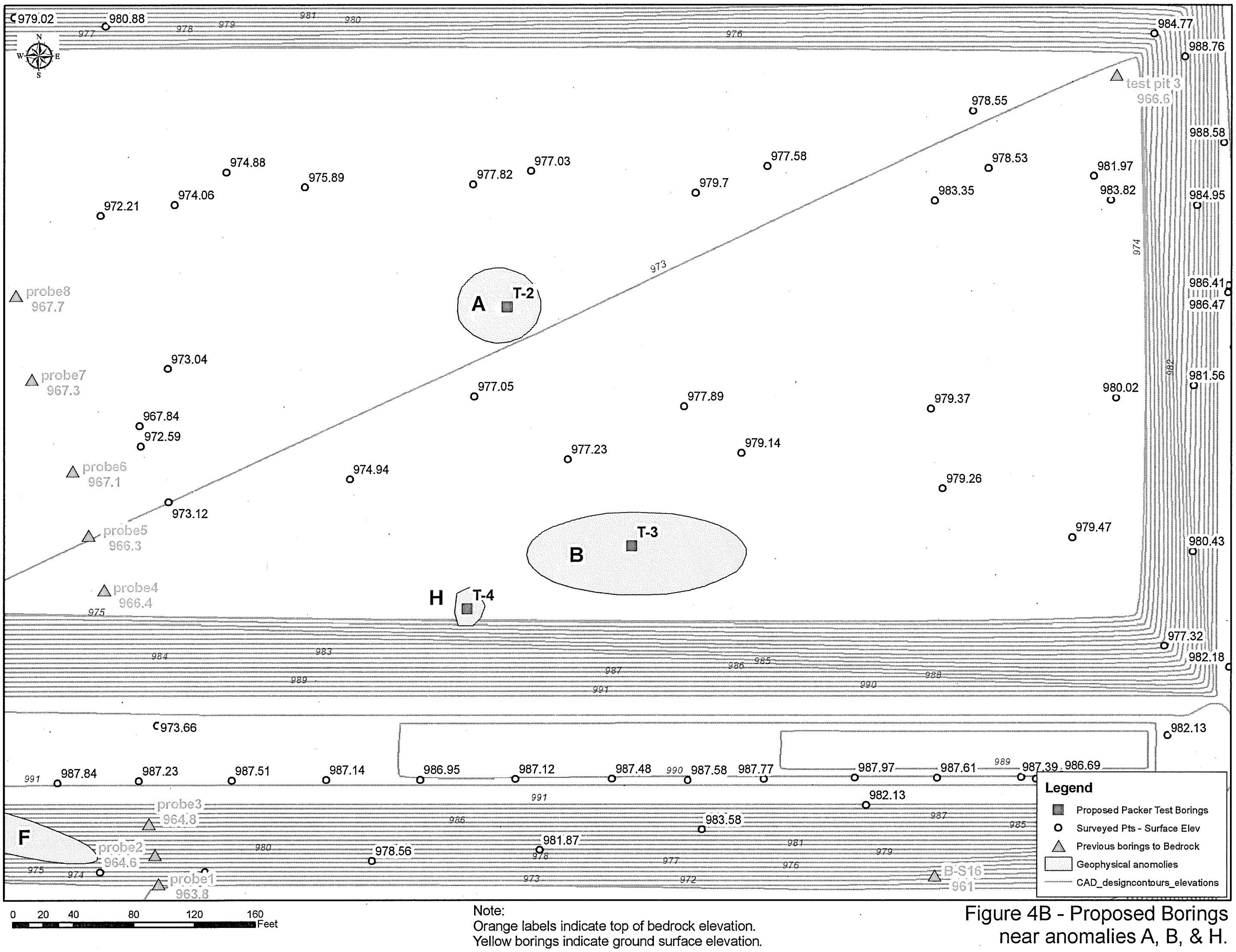


Figure 3 - Proposed Borings for Packer Tests



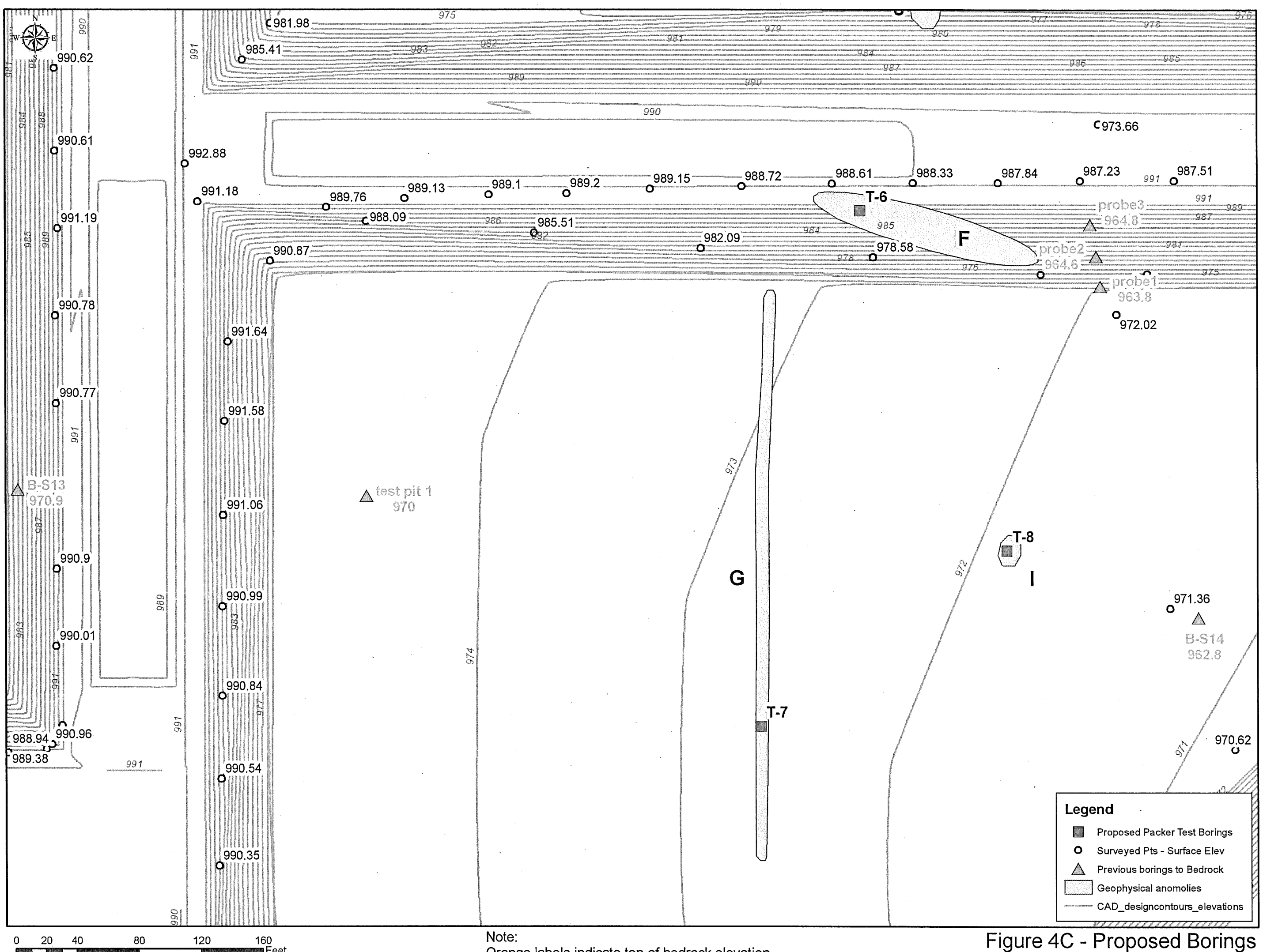
Note:
Orange labels indicate top of bedrock elevation.
Yellow borings indicate ground surface elevation.
* bedrock not encountered

Figure 4A - Proposed Borings near anomalies C & J.



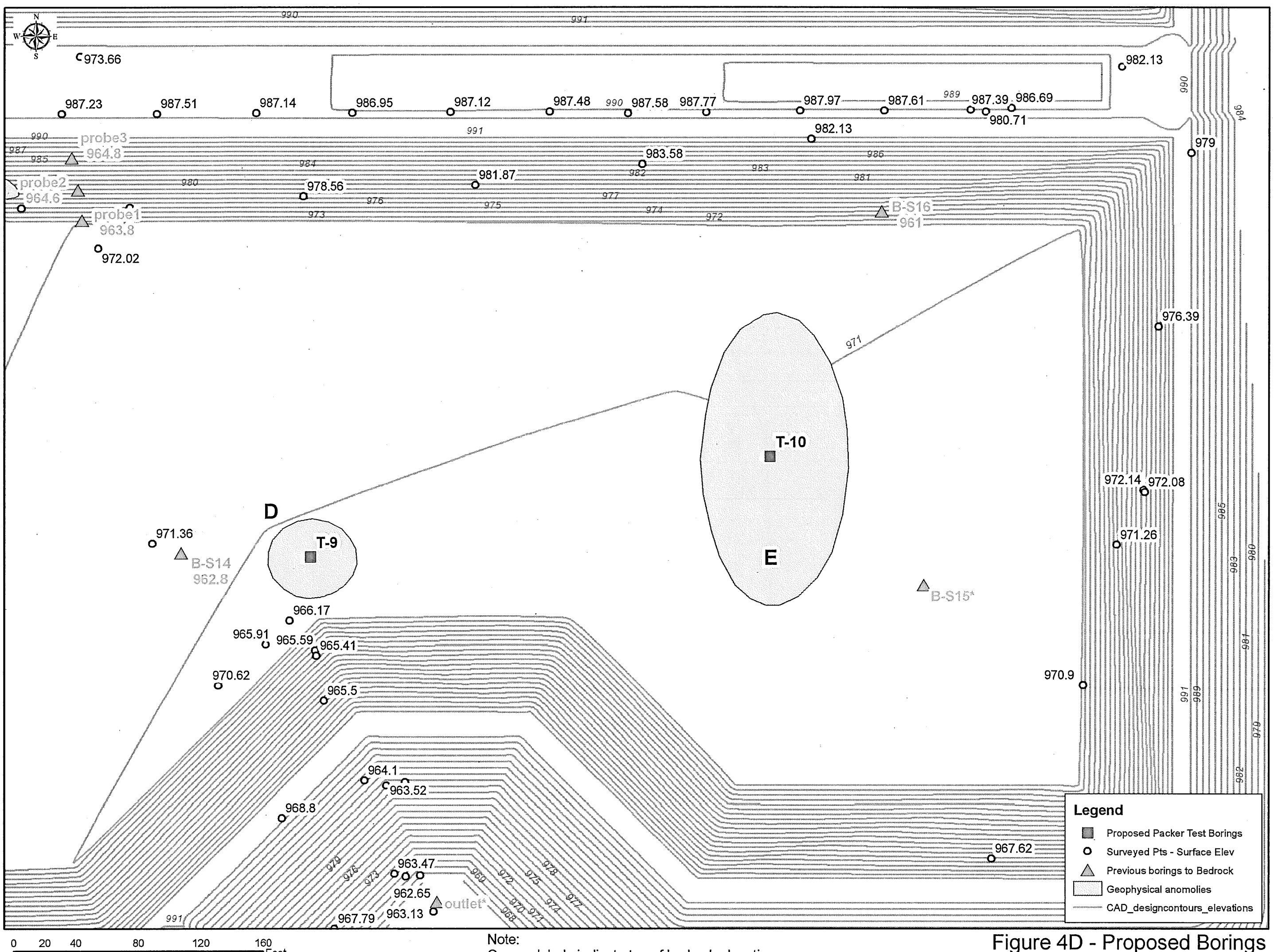
Note:
Orange labels indicate top of bedrock elevation.
Yellow borings indicate ground surface elevation.

Figure 4B - Proposed Borings near anomalies A, B, & H.



Note:
Orange labels indicate top of bedrock elevation.
Yellow borings indicate ground surface elevation.

Figure 4C - Proposed Borings near anomalies F, G & I.



Note:
Orange labels indicate top of bedrock elevation.
Yellow borings indicate ground surface elevation.
* bedrock not encountered

Figure 4D - Proposed Borings near anomalies D & E.

Fromm Applied Technology
13129 North Green Bay Road
Mequon, Wisconsin 53097
(262) 242-4280

September 20, 2011

Mr. Dave Trainor
NewFields
2110 Luann Lane
Suite 101
Madison, WI 53713

Dear Mr. Trainor:

Background Introduction

This letter report summarizes the electromagnetic (EM31) survey, the capacitance coupled resistivity (CCR) survey, and the 2-D electrical resistivity CCR pseudo sections conducted at the Tradition South Dairy site_between the 8th and 15th of September 2011. This document is not intended to be used by the general public; it is intended as a tool to assist professionals who perform geophysical, geologic, environmental, and/or engineering investigations. The acquisition of geophysical data and/or this report are not intended to relieve or minimize the above, their client(s), the owner's, the operator's, and/or others' of their responsibilities associated with the safety and planning of any or all concerns associated with the survey. An effort, which clearly exceeded the scope of the proposal, was made to provide clear details, analysis, presentation, and limited interpretation of the geophysical investigation. Interpretations are or may be made of the geophysical results in an attempt to predict conditions at depth. Note that with electrical methods, bulk apparent resistivities and conductivities are recorded and are generally unique. For this investigation, a series of bulk conductivities and resistivities utilizing various geometries were acquired. At three locations electrical resistivity pseudo sections were created and then modeled, in an attempt to visualize conditions at depth. Because the interpretation and modeling of electrical data is not unique, identifying anomalies of concern and determining unit resistivities is difficult. The approved geophysical investigation program consisted of conducting a preliminary geophysical investigation to assist with identifying features such as filled sinkholes, vertical and lateral connections between sinkholes, and hydraulically active bedrock fractures, utilizing electrical methods. Electrical methods are often used to map variations in electrical conductivity or electrical resistivity associated with changes in saturated porosity, fracture density, clay mineral content/in-filling, voids, pore fluid conductivity/resistivity, and fill. For this investigation, apparent conductivities are expected to increase and apparent resistivities are expected to decrease with an increase in saturated porosity, an increase in the volume of clay minerals, and with an increase in pore fluid conductivity (decrease in resistivity). Fill material and buried metal are not expected to be encountered at this site. While the underlying limestone unit is expected to be saturated, the degree of saturation of the soils is not known throughout the survey area. An EM31 survey was conducted in the north basin area, which is expected to have a soil thickness somewhat less than the depth of penetration of the EM31, and a CCR survey was conducted in the south and west basin areas where soil thickness was expected to exceed fifteen feet at many locations. The intent of the investigation is to map geophysically detectable variations in apparent conductivity/resistivity that would be used to assist with placing future drilling locations and possibly excavations, in areas determined by others.

Methodology

As shown in **Figure 1: Tradition South Dairy—Locations of Data Points for the EM31 and Capacitance Coupled Resistivity Surveys**, the EM31 and resistivity surveys yielded more than 16,000 measurements over approximately 12 miles of lines. The lines were located on accessible portions of the site. The average station spacing was approximately 4 feet between readings. Data was acquired on lines spaced approximately 20 feet apart. Data was acquired on smaller station spacing then proposed to guarantee the sampling requirements were met. The most accurate placement of points in the field would be determined by referencing the general grid system established at the site. Wooden lathes were placed on approximately a 200 by 200 ft grid. The EM31 instrument in the vertical dipole mode with a fixed coil spacing yielded an approximate depth of penetration of 18 feet. The instrument was used to acquire the quadrature (apparent conductivity) response. A base station was used to initialize the instrument and to demonstrate repeatability. The CCR instrumentation is designed to duplicate a dipole-dipole electrical resistivity survey. The survey utilized current and potential electrode spacing of 20 meters with a N factor 1.75. This configuration was intended to represent an approximate median depth of penetration of 41 feet. 2-D electrical resistivity pseudo sections were acquired to assist with characterizing the site in cross-section. To achieve the multiple depths of penetration needed to create a pseudo section the geometry of the CCR array was varied. The Dipole-Dipole configuration utilized 5, 10, and 20 meter "A" spaces with n equal to 1 and 1.75. These configurations were intended to represent approximate median depths of penetration between 7 and 41 feet. The results of these six configurations are demonstrated in the plots for the pseudosections. The depths of penetration can be strongly dependent on subsurface conditions.

Results of Mapping North and South Basins

Figure 2A: Tradition South Dairy—Contour Plot of Acquired EM31 and Capacitance Coupled Resistivity Data Without Gaussian Filter and **Figure 2B: Tradition South Dairy—Contour Plot of Acquired EM31 and Capacitance Coupled Resistivity Data With Gaussian Filter** present the EM31 and CCR data as a contour maps. In contrast to the electrical resistivity surveys, which measure apparent resistivities, the EM31 survey measures apparent conductivities. These two measurements are inversely proportional. As apparent resistivities increase apparent conductivities decrease. The result of contouring the acquired apparent conductivity data with an EM31 is shown in upper portion of Figure 2A and Figure 2B with the remaining contoured results reflecting changes in apparent resistivity. Interpreted high apparent conductivity values are contoured in shades of dark blue. Low positive conductivities are contoured in shades of yellow with intermediate values shaded in blue and yellow. Before the resistivity data was contoured apparent resistivity values that were below 5 ohm*m and greater than 150 ohm*m were removed. The data that were removed are represented by the blank spots in the posted data, shown in Figure 1. To assist with removing additional bull's eye type anomalies that fell between 5 and 150 ohm*m, a Gaussian filter was applied. Figure 2A presents the resistivity results without a Gaussian filter. The results after filtering are shown in Figure 2B. In both figures the interpreted low apparent resistivity values are contoured in shades of light blue. High apparent resistivities are contoured in shades of red with intermediate values shaded in light blue and red. Again, the focus of the investigation is on locating areas that demonstrate an increase in porosity, not associated with primary porosity. Small scale empty voids or voids filled with electrically resistive material like sand and/or gravel are difficult to detect. If spatially large enough, non-primary void spaces filled with water or soils rich in clay minerals are anticipated to increase the apparent conductivity and/or decrease the apparent resistivity.

Because of the size of the survey area and the vast number of possible interpreted zones of interest, examples are provided interpreting several possible site conditions that may lead to an increase in non-primary porosity. Because soil thickness and soils rich in clay minerals can vary electrical measurements the highest level of confidence for locating areas of concern are placed on electrical measurements acquired in areas with the least overburden or with a constant overburden thickness. An observed correlation between topography and the contour plots may be interpreted as the electrical results mapping variations in soil thickness. However, local variations in electrical measurements within an area with little to no overburden or areas that are expected to have constant overburden thickness may be interpreted as variability within the limestone unit. Variability of electrical measurements in areas with greater overburden may also reflect changes within the soil. Thus, the source of the variations would need to be determined by other means of investigation. Examples of such variations or anomalies are shown in Figure 2A and Figure 2B. The examples are labeled A through J. In the north basin anomaly (A) is interpreted as a non-linear anomaly that is more or less a closed feature yielding higher apparent conductivity values at lower elevations, anomaly (B) is interpreted as a non-linear anomaly that is a spatially wider version of (A) yielding high apparent conductivity values at lower elevations, and anomaly (C) is interpreted as more or less a linear anomaly associated with relatively high apparent conductivity values. In the south basin, anomaly (D) is interpreted as a non-linear anomaly that is more or less a closed feature yielding lower apparent resistivity values at lower elevations, anomaly (E) is interpreted as a non-linear anomaly that is a spatially wider version of (D) yielding low apparent resistivity values at lower elevations, anomaly (G) is interpreted as more or less a linear anomaly associated with relatively low resistivity values, and anomaly (F) is interpreted as an area that apparent resistivity data points were filtered out in a contiguous area as seen in Figure 1.

Results of Electrical Resistivity Pseudosections/Models

Interpretations of measured and modeled geophysical results are often utilized to predict the geologic conditions at depth. Three electrical resistivity pseudosections/models were created. The pseudosections present the data as a kind of cross-section along Y=35 feet between approximately X=175 to 1050 feet, along Y=-320 feet between approximately X=175 to 1050 feet, and along approximately X=-200 feet between approximately Y=-320 and 320 feet. Before the data was modeled, a cubic spline was applied to smooth the data and limit isolated spikes that do not fit the general trend of the data set. A computer program provided by AGI called Earth Imager was utilized to invert the acquired electrical resistivity results. The intent of the inversion is to produce a reasonable approximation of the geology at depth. The results of inverting and contouring the dipole-dipole electrical resistivity pseudosection data are shown in **Figure 3: Tradition South Dairy—Electrical Resistivity 2-D Pseudo Section and Inversion Along Y=35 in North Basin Area, Figure 4: Tradition South Dairy—Electrical Resistivity 2-D Pseudo Section and Inversion Along Y=-320 in South Basin Area**, and **Figure 5: Tradition South Dairy—Electrical Resistivity 2-D Pseudo Section and Inversion Along Approximately X=-200 in West Basin Area**. The inversion models, the bottom contour plot in Figures 3, 4, and 5, were set to range from about 5 ohm*m to approximately 1000 ohm*ft. Distances along the line are shown at the top of each representation of the data. The color scheme for contouring the resistivity results is shown along the side of the plot. The upper plot in each figure reflects the field results while the middle plot presents the calculated apparent resistivities used to create the inverse model shown at the bottom of the figure. The inverse model shown at the bottom of each figure depicts changes in unit resistivities with depth along the surveyed line. Inverse models from within an excavated setting may indicate RMS errors that seem fairly high. Generally, it is thought to be associated with closely spaced data acquired within a disturbed setting or uneven terrain causing the array to bounce while being towed. In addition, data acquired with stations spaced less than 5 feet apart can record changes that are not easily processed by the inversion software. While the modeling process does not yield a unique solution, the models are interpreted to generally correlate well with conditions at depth. Depths are provided and may accurately represent variations in geology at depth; however depths are often best used as a relative gauge. The accuracy of the depth estimate can be improved by correlating the results with borings. Three additional examples are provided that are in keeping with the above discussion. The examples are labeled H, I, and J. The anomaly at (H) is interpreted as a zone of relatively low inverted resistivity values that are cutting vertically through the 2-D cross section in an area with less expected overburden. The anomaly at (I) is interpreted as a relatively wide zone of lower inverted resistivity values in the inverted 2-D cross section. The anomaly at (J) is interpreted as a zone of high inverted resistivity values. High resistivities can be interpreted as possibly an area with more competent and/or less weathered rock or possibly an unsaturated void space.

Summary

The actual sources of the anomalies presented in Figures 2 through 5 cannot be inferred from the data and must be determined by other means of investigation. Geophysical methods can not clear a site of possible areas of concern or conclude that the interpreted anomalies that are presented are a concern. Ground truthing plays an important role in a geophysical investigation. A discussion on methods of ground truthing geophysical anomalies is outside the scope of this report.

The electrical results, Figures 2, 3, 4, and 5, were able to differentiate between regions of high and low apparent conductivity/resistivity for various depths of penetration. The geophysical methods utilized in this investigation were able to provide detail that is far greater than a limited boring program; however, the methods used are more or less qualitative in nature. The shallow resistivity results appeared to be influenced the most by near surface conditions. The results indicate discrete areas that may deserve further investigation. Anomalous areas are interpreted to be associated with variations in electrically conductive clay content, saturated porosity, pore fluid resistivity, and/or unknown fill material. Inverse models of the resistivity pseudosections yielded depths to resistivity units. While the models generally yield good depth estimates, they are often a better indicator of relative depth and often increase in accuracy once correlated with boring results. After all is said and done, a geophysical analysis is based on indirect methods and is often limited by the availability of direct observations; thus, additional analysis and interpretation is often necessary as additional information becomes available. It is extremely important to point out that while interpretations of the results mapped out lateral variations in the subsurface, this report cannot conclude if these variations are beneficial or detrimental to any use of the property. In conclusion, a very dynamic and integrated geophysical approach was utilized to investigate the Tradition South Dairy Site. Resistivity and EM31 methods offered a cost effective high-resolution approach for investigating subsurface condition in the vicinity of the site.

STANDARD DISCLAIMER

The objective of any geophysical survey is to define the existence and configuration of features at depth. However, these features may bear a highly complex relationship to the geophysical measurements recorded. Therefore, conclusions drawn, no matter how logically deduced, should not be misconstrued as fact. We shall not and will not, except in the case of gross or willful negligence on our part, be liable or responsible for any losses, costs, damages or expenses incurred or sustained by anyone resulting from any interpretation made by any of our officers, employees and agents or by anyone else not related to Fromm Applied Technology who might base interpretations and opinions on our geophysical surveys.

Thank you and if you have any questions please feel free to call.

Sincerely,
Arthur J. Fromm

Figure 1: Tradition South Dairy—Locations of Data Points for the EM31 and Capacitance Coupled Resistivity Surveys

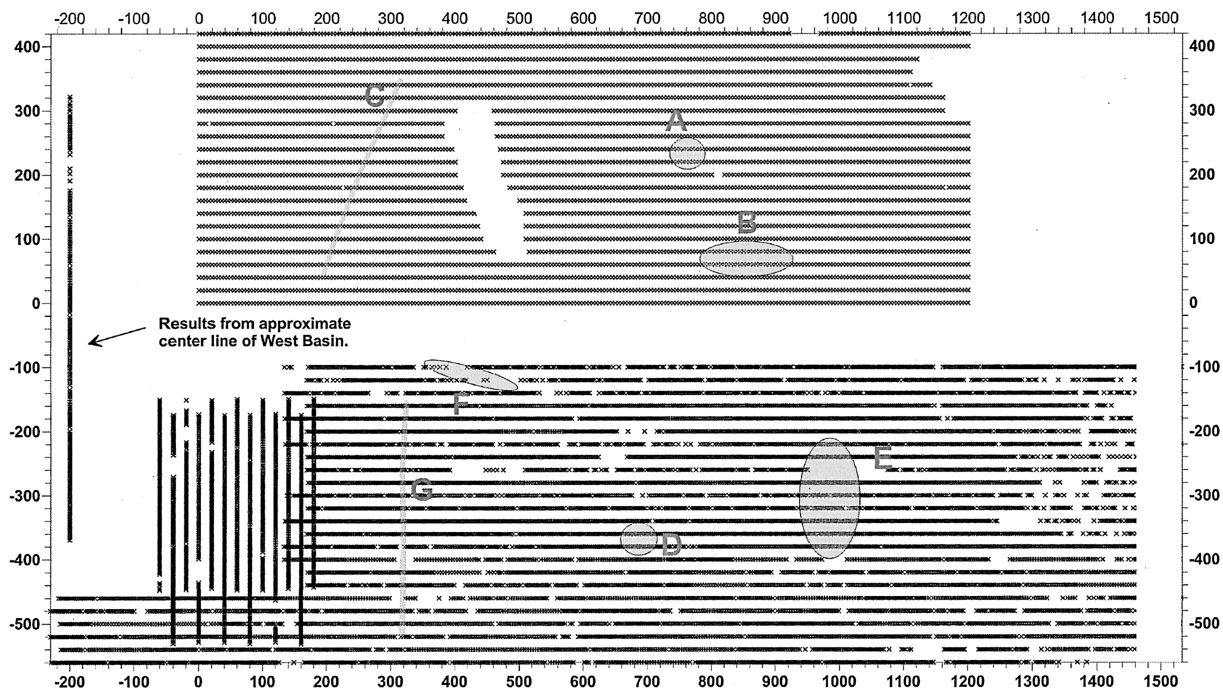
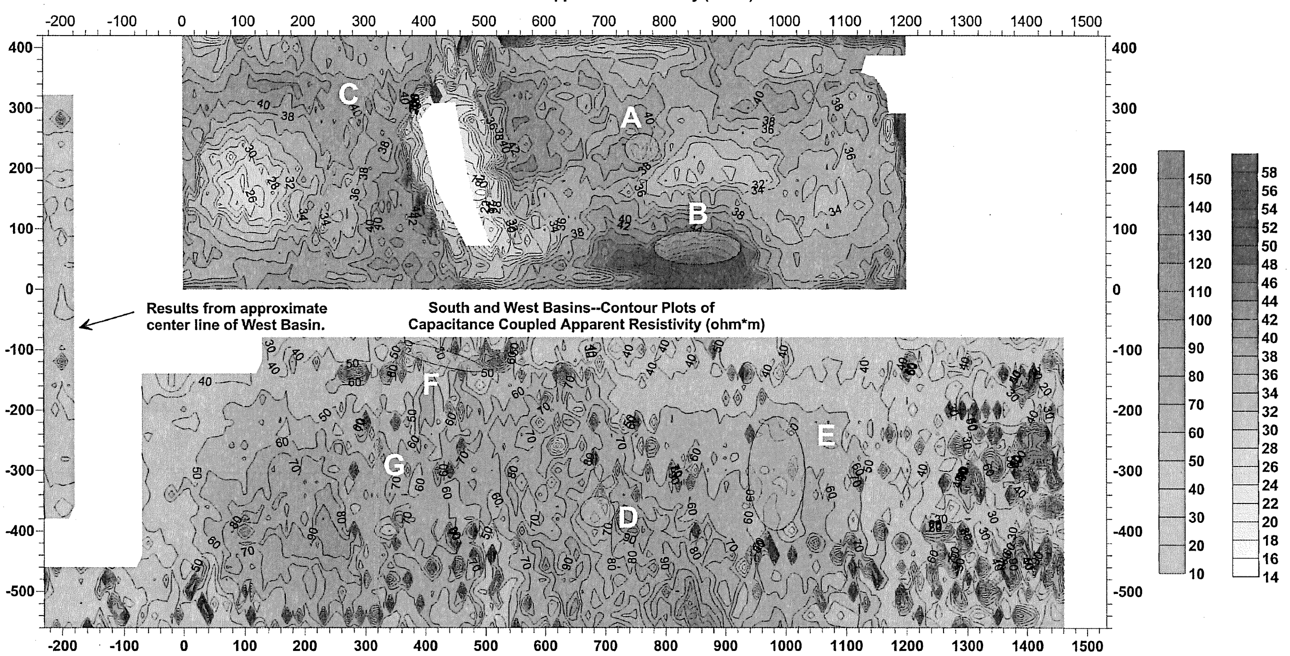


Figure 2A: Tradition South Dairy—Contour Plot of Acquired EM31 and Capacitance Coupled Resistivity Data Without Gaussian Filter

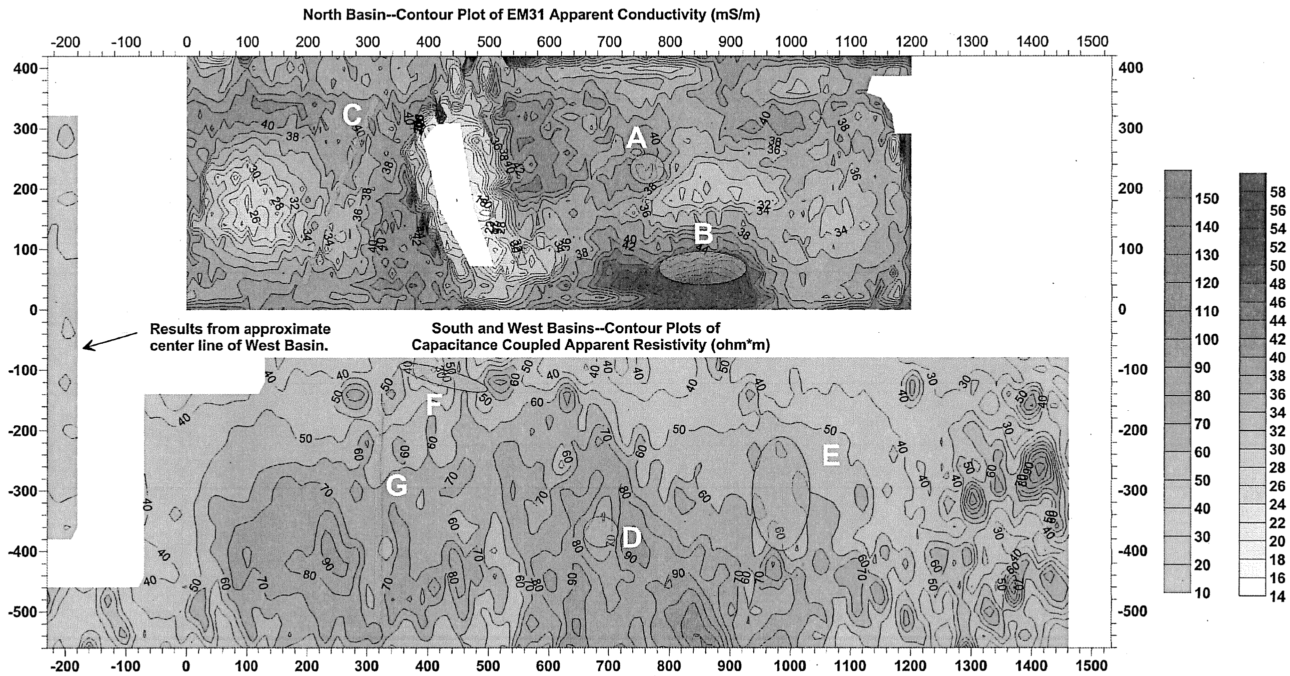


Highest level of confidence is in areas with the least overburden or constant overburden thickness.
Apparent resistivity or conductivity values maybe affected by variations in soils in areas with greater overburden.
Apparent resistivity is inversly proportional to apparent conductivity. If resistivities decrease apparent conductivities increase.
All references to elevations are subjective and need to be confirmed by other means.
Note, less then five days were provided for presentation and interpretation of results.

Examples of anomalies that are interpreted as possible areas of concern (see report):
North Basin
A) A non-linear anomaly that is more or less a closed feature yielding higher apparent conductivity values at lower elevations.
B) A non-linear anomaly that is a spatially wider version of A) yielding high apparent conductivity values at lower elevations.
C) A more or less linear anomaly associated with relatively high apparent conductivity values.

South Basin
D) A non-linear anomaly that is more or less a closed feature yielding lower apparent resistivity values at lower elevations.
E) A non-linear anomaly that is a spatially wider version of D) yielding low apparent resistivity values at lower elevations.
F) An area that apparent resistivity data points were filtered out in a contiguous area on adjacent lines may reflect real conditions at depth; thus, a possible area of concern.
G) A more or less linear anomaly associated with relatively low resistivity values.

Figure 2B: Tradition South Dairy—Contour Plot of Acquired EM31 and Capacitance Coupled Resistivity Data With Gaussian Filter



Highest level of confidence is in areas with the least overburden or constant overburden thickness.
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Apparent resistivity is inversely proportional to apparent conductivity. If resistivities decrease apparent conductivities increase.
All references to elevations are subjective and need to be confirmed by other means.
Note, less then five days were provided for presentation and interpretation of results.

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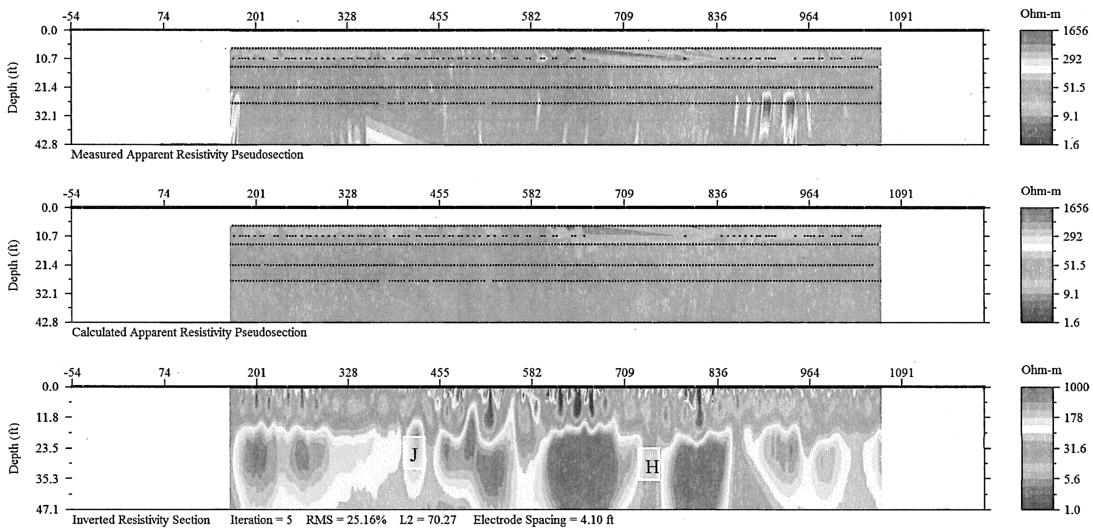
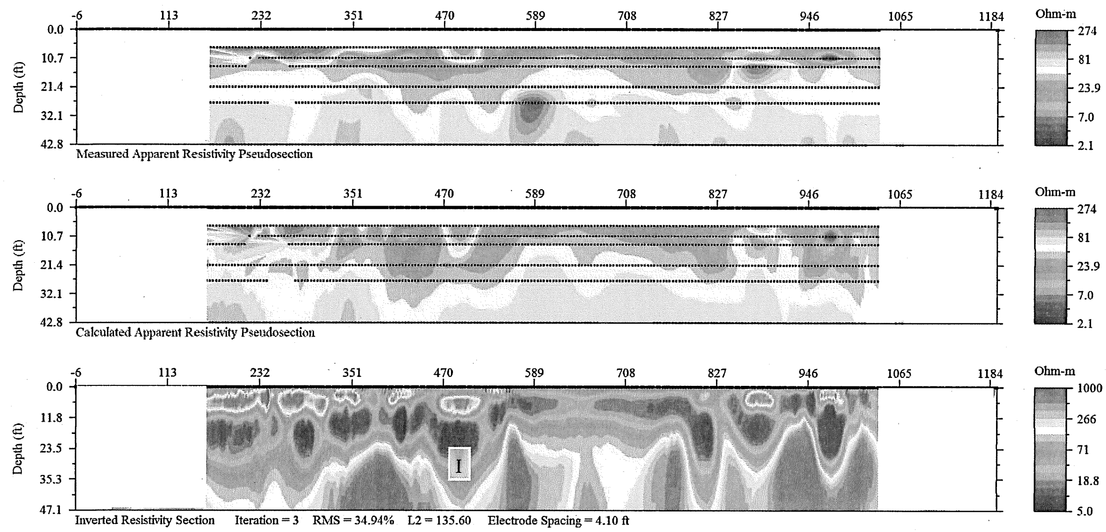
F) An area that apparent resistivity data points were filtered out in a contiguous area on adjacent lines may reflect real conditions at depth; thus, a possible area of concern.
G) A more or less linear anomaly associated with relatively low resistivity values.

Figure 3: Tradition South Dairy—Electrical Resistivity 2-D Pseudo Section and Inversion Along Y=35 in North Basin Area



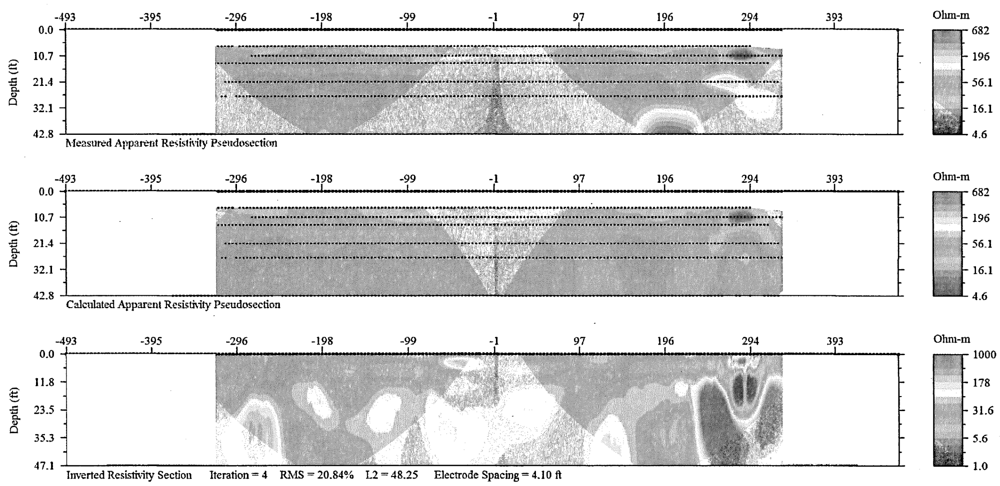
H) Zone of relatively low inverted resistivity values cutting vertically through the 2-D cross section in an area with less expected overburden.
J) A zone of high inverted resistivity values. Possibly an area with more competent and/or less weathered rock or possibly an unsaturated void space.

Figure 4: Tradition South Dairy—Electrical Resistivity 2-D Pseudo Section and Inversion Along Y=-320 in South Basin Area



I) A relatively wide zone of lower inverted resistivity values in the inverted 2-D cross section.

Figure 5: Tradition South Dairy—Electrical Resistivity 2-D Pseudo Section and Inversion Along Approximately X=-200 in West Basin Area



Note, this section appears to have lower overall resistivity values, which are interpreted to be caused by soils from the very close adjacent sidewalls to the east and west.